EMBO reports

The communications gap between scientists and public

More scientists and their institutions feel a need to communicate the results and nature of research with the public

Philip Hunter

Public outreach has become an issue of growing importance for science. Many scientists and scientific institutions feel a need to inform the public about potentially dangerous misconceptions or to counter a continuing barrage of misinformation from numerous quarters including commercial lobbies and fundamentalists. In fact, there are alarming deficits in the public's understand of science, as was highlighted this year in a study by the Wellcome Trust, which found that only 9% of respondents were aware that antibiotic resistance means that bacteria are resistant to antibiotics (https://wellcome.ac.uk/sites/default/files/antibiotic-resistance-graphic-wellcome-apr16.pdf). More than three times as many, 31%, think that it is their own bodies that have become resistant to antibiotics. Similar levels of ignorance have prevailed regarding the fact that antibiotics kill only bacteria and not viruses, and are therefore not suitable for treating flu or the common cold.

A lack of trust

There has been debate over where the blame lies for such ignorance, but most observers now apportion it in varying measures between scientists, science writers or journalists, and the public itself. Institutions also carry some responsibility due to expending more effort bolstering their own reputations, rather than meticulously reporting their research. Indeed, public resistance to scientific messages may stem in part from the continuous stream of exaggerated claims, according to Charles Seife, Professor of Journalism at New York University. "Some of the reasons for the resistance come from the fact that history is littered with self-serving, incorrect, and even dangerous pronouncements in the name of science", he said. "It would be a very stupid and bovine population that actually believed every official statement declaring a "breakthrough" in science. Anyone who trusts blindly in "science", thinking that even the most corporate of research is pure and unsullied by commercial interests, is incredibly naive".

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Seife argues that scientists need to be more aware of possible reasons for communication failure with the public. "If you're going to communicate effectively, you're going to have to understand the reasons your message might not get across", he explained. "There are all kinds of reasons that a scientific message will meet resistance, including political and economic, as in the case of global warming, religious, as in the case of natural selection and big bang theory, and social, as in the case of anti-vaccine movements".

The points about public resistance and ignorance have been picked up at Leiden University in the Netherlands, where Ionica Smeets took over recently as Professor of Science Communication. "I think it is important in science communication to be aware of what the general public knows", said Smeets, referring to the Wellcome Trust study on understanding antibiotic resistance. This message will be reflected in research led by Smeets into how best to teach public outreach skills as part of degree and post-graduate courses.

Peer pressure and perception

If lack of public knowledge were the only problem for science communication, it would at least be clear what needed to be done: devoting more resources on educational and informational programmes. Unfortunately, there are more intractable issues relating to trust, emotion and misinformation that cannot just be countered by messaging.

"Mis-information from lobby groups is a more serious problem", commented Stephen Curry, Professor of Structural Biology at Imperial College in London, UK, and a dedicated science communicator. "This is something that was very much to the fore in the Brexit debates in the UK and was very frustrating for the scientific community. We have to tackle it not by abandoning our respect for evidence, but by adding some passion to the argument, about our belief in the value of research, preferably coloured by stories of how it helps the general public, and being up front about our vested interests".

Yet, the science communication problem goes deeper than misinformation, with some

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suggestions that it is deeply rooted in human evolution. One study led by Dan Kahan, who specializes in risk perception and science communication at Yale Law School in the USA, dissected the reasoning and attitudes of parents who refuse to have their children vaccinated [1]. Kahan argued that "both to avoid dissonance and to protect their ties to others, individuals face a strong psychic pressure to conform their perceptions of risk to those that distinguish their group from competing ones". This is a major problem for communication because such dissonance appears to be immune from facts and evidence, and determined entirely by deeply rooted social factors. Such bias can actually be intensified as the public becomes more science literate, Kahan argued in the paper, indicating why pseudoscience can be so effective.

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On top of peer pressure, individual psychology can also affect judgement of risk and probability and in turn shape how messages are received or interpreted. Human judgement is also affected by metabolic factors including how recently the subject had a meal, as Curry pointed out. "Risk is something that all human beings find difficult to judge", he said. "Read the works of Daniel Kahneman if you want to get a good sense of how easily our evaluative judgments are perturbed by factors that seem innocuous, such as how hungry we are". In his 2011 book *Thinking, Fast and Slow* to which Curry is primarily referring, Kahneman, a Nobel Prize winning economist, gives numerous examples of bias in assessing risk and statistics, including some involving science communication.

Given that a lack of statistical literacy, as well as cognitive dissonance, are common to all people, including scientists, there is not much that science communicators can do directly about these deep-rooted issues, according to Jeanne Garbarino, Director of Science Outreach at Rockefeller University in the USA. "There is not a single solution for this issue, but I do think that fostering critical thinking skills from a young age will help in the future".

Targeting audiences

But communicators can and should at least attend to the half of the problem that they do have control over: the engagement process itself. "I often see communicators making the quite arrogant assumption that an audience wants to hear about, or even cares about, their message", Garbarino said. "I also see scientific messages framed in ways that are inaccessible to some audiences, either because they are presented at technical levels, or because they don't frame the issue at hand in a way that is relevant to the lives of the intended audience".

Rockefeller has therefore focused on framing their messages for a variety of audiences, with Garbarino citing its annual science festival for children aged 5–13, Science Saturday (www.parentsandscience.rockefeller.edu/sciencesaturday) as an example. "Here, we bring together over 100 local scientists to present hands on demonstrations and experiments to kids as they move about the festival", she said. "We typically have about 35 unique learning stations, categorized by areas such as 'life sciences,' 'chemistry,' and 'engineering.' Knowing the audience is key, and since this is an incredibly diverse group, we work very hard on understanding our key message for each learning station, and make sure that the delivery is exciting, concise, and age appropriate". Garbarino also cited other US projects, including the BioBus (http://biobus.gsu.edu/about), The Story Collider (http://www.storycollider.org) and numerous programmes at the American Museum of Natural History. Garbarino's experience is that outreach has become a popular activity amongst scientists, and many think that it is, or should be, an integral part of their work.

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This sentiment is also shared by a number of European bodies dedicated to outreach, such as the British Science Association (BSA). "My own experience has been that scientists enjoy communicating their work – it's always delightful to see others getting interested in a topic that you find fascinating", said Katherine Mathieson, recently appointed Chief Executive of the BSA. The BSA has been partnering with the Story Collider to bring its events to the UK, as part of its programme to broaden science communication.

There is also a growing emphasis on science communication as a two-way process by which the course of research can be influenced by societal feedback, according to Anna Perman, the BSA's Communities Manager. "It's vital to expose scientists to a range of different fields", she said. "Embracing the creativity inherent in science can open up routes for collaboration, and many scientists say working with artists, journalists, and people from other fields improves their research. That's why we've started Culture Shock, a series of events where each brings together scientists and people from a particular field, for instance, the arts, campaigning groups, or sportspeople. We think this will foster innovation and help break down some of the siloes that exist in our culture".

Communicating uncertainty

There are similar efforts elsewhere in Europe, and often come from established research institutes or universities rather than dedicated science communication bodies, such as the BSA. The European Molecular Biology Laboratory (EMBL) in Germany for instance aims to raise its public profile through more public communication. "I came from CERN, another intergovernmental research organisation like EMBL, where I was Head of Content", said Dan Noyes, EMBL's Joint head of Strategy and Communications. "CERN enjoys a high profile amongst the general public — many people have heard of CERN, generally understand what it does ("physics"), and have a positive impression of it. EMBL is seeking to develop a similar profile: to be recognised, understood, and have a positive impression". The key challenge, Noyes said, lies in getting the right level and tone. "Too close to the science and it becomes too difficult for a large proportion of the audience, too far from the science and it lacks authenticity and risks

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being rejected by the scientific community. You need to find a way to bridge this level". In revising EMBL's communications strategy, Noyes is following two core principles. "Firstly every piece of content, and every engagement point, should be the start of a journey. An interested reader, viewer or listener should then be able to discover more of what interests them in our content. Then, secondly every piece of content should somehow impart wonder".

Noyes also suggests that scientists should be more honest about the nature of the research and the uncertainties involved, even at risk of sowing confusion. "Science is hard. It's slow. It's full of failures and dead ends. But it's also infinitely wonderful", he said. "In terms of specific initiatives, I think something what is key is how EMBL will approach risky topics in its communications, and how mature it will be in leading and joining conversations that it can inform and shape but ultimately cannot control".

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Noyes cites CERN's experience in the run-up to starting the Large Hadron Collider in September 2008. "The imminent commissioning of the machine caused great anxiety in a small segment of the population that the LHC could be extremely dangerous, causing, for instance, a black hole that would somehow end the universe", Noyes noted. "CERN's response to this was incredibly mature. It didn't go around trying to say that this wasn't true: it saw this conversation as an opportunity to inform, sharing the science behind the LHC's safety committee, but also going so far as to say that the formation of a black hole, while unlikely, would be incredibly cool, as well as safe, because it could open the door on a theory called supersymmetry".

The role of journalists

Such an approach might help alleviate some of the more extreme overreactions to breaking science news, a good example of which was the media reaction to the Pathomap study, which applied genomic analysis to take a microbial snapshot of the whole New York subway [2]. Public fears were stoked up by findings of various pathogenic bacteria amid the city's "microbiome". "This caused a pretty big stir, particularly because terms like "anthrax" and "bubonic plague" were thrown around in ways that were a bit irresponsible", said Garbarino. "Genomic data is complex, and explaining or communicating genomic data and findings is truly difficult, especially to non-scientific audiences, but it can also leave room for a bit of panic when done wrong. While there could have been a bit more clarification in the primary paper itself, and points requiring further clarification were promptly addressed by the PI of the study, some media outlets exaggerated or flat-out misinterpreted the implications of these data".

The problem of exaggerating scientific findings can only be addressed by scientists in collaboration with more responsible media outlets. But it raises the issue of what role the media should play in science communication, with a dichotomy between informing the public and acting as watchdog. Perhaps they should do both, but the two roles should not be confused, commented Peter Aldhous, who is a science journalist and teacher in the Science Communication Program at the University of California, Santa Cruz, USA. "I have some misgivings about the label 'science communication', especially when it is used as a broad umbrella to describe both journalism and PR", he said. "Those are two very different functions, in my view, serving very different interests. I feel that too often, they are blurred when it comes to science. Ultimately, I believe that [it] does not serve society well".

Journalists should serve the public rather than science, Aldhous argued, and this means not so much merely explaining what people are doing but, where relevant, challenging their work and findings. "Part of my job as a science journalist is to report on wrongdoing by scientists, triggering a number of retractions and corrections in the scientific literature", said Aldhous. "Here, the different agendas of journalism and PR in science are especially obvious".

Social media

However, these agendas are increasingly intermingling on social media outlets, which have become important modes of public communication for both scientists and journalists. While these channels have huge potential for amplifying knowledge, they can equally spread misinformation; indeed, this is more likely to go viral than reliable information from scientists. Herein lies another challenge for scientists to counter propaganda and hysteria on social media, as well as to engage more directly with people. In particular, being open about uncertainties and open questions could help earn public trust in science. This is also one of the messages of a recent white paper prepared for the American Association for the Advancement of Science (http://www.aaas.org/sites/default/files/content_files/public%20engagement%20social%20media_Yeo_single.pdf). It argues that on the whole, it is a good thing to communicate uncertainty even if, in some cases such as anthropogenic climate change, it can raise the impression that there is more doubt within the field than actually exists.

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There have now been various studies to identify effective online and social media strategies for science communicators; the most important insight is that it is still the message that matters rather than the medium. Blogs are unlikely to have an impact when circulated via Facebook or Twitter if they are targeted at peers and written with a lot of technical jargon. Nonetheless, and despite all their shortcomings, social media still offer an effective communication channel for scientists to engage with the public and eventually help to overcome misperceptions, counter misinformation and maintain public trust in research.

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